

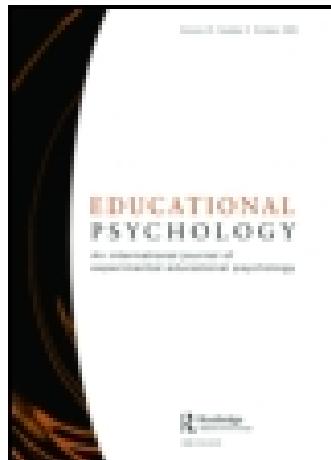
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### The Relationship between Cognitive Style and Intelligence

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## *The Relationship between Cognitive Style and Intelligence*

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**ABSTRACT** *The relationship between intelligence, as measured by the short form of the British Abilities Scales, and the Wholist-Analytic and Verbal-Imagery style dimensions, as assessed by the Cognitive Styles Analysis, was investigated with 119 12-13-year-old middle school pupils (63 males and 56 females). Near zero correlations between intelligence and the styles were found. A Test of Embedded Shapes was also given and this correlated significantly with intelligence, but not with style. The effect of intelligence and style on performance on a range of school subjects was considered, and this showed significant main effects of intelligence and both of the styles. The results were discussed in terms of the nature of intelligence and cognitive styles.*

The intention of this present paper was to examine the relationship between cognitive style and intelligence. These, potentially, constitute two basic areas that could affect performance, but it is necessary to determine the extent to which they are different aspects of ability. The two areas will be examined in turn.

### **Intelligence**

In considering intelligence one is faced with the situation that, while in practical terms the construct is widely accepted, there is considerable difficulty with its definition and scope (see, for instance, Jonassen & Grabowski, 1993, p. 43). The range of opinion is very broad, from, on the one hand, a position that views intelligence as encompassing multiple abilities (Gardner, 1983), through a wide range of behaviour (e.g. Sternberg, 1985), to a much more narrow conceptualisation, with an emphasis on reaction time or inspection time (see Kline, 1991, p. 97-106), and at the other extreme, to those who question whether it even exists at all (e.g. Howe, 1990).

In the present context, where it is intended to compare intelligence with cognitive

styles in order to identify similarities and differences, the all-embracing approach is inappropriate, as it assumes that intelligence subsumes all abilities. In any empirical research the approach to intelligence is determined by the measure chosen to assess it as, in practical terms, intelligence is what intelligence tests measure (Boring, 1923). In the present study, an instrument widely used in the UK, the British Abilities Scales (Elliot, 1983) Short-Form, will be used. The Short Form subtests are capable of adaptation for group administration and give an IQ.

### Cognitive Styles

Cognitive style has been defined by Tennant (1988) as "an individual's characteristic and consistent approach to organising and processing information". In the present context, a cognitive style is considered to be a fairly fixed characteristic of an individual, in contrast to strategies which are the ways that may be used to cope with situations and tasks. Strategies may vary from time to time and may be learned and developed. Styles, by contrast, are static and are relatively in-built features of the individual.

### Cognitive Style Families

Several researchers (e.g., Brumby, 1982; Miller, 1987; Riding & Buckle, 1990) have argued that a number of cognitive style labels are actually different conceptions of the same dimension. Riding and Cheema (1991) surveyed the various labels and concluded that they may be grouped into two principal cognitive style groups which they termed the Wholist-Analytic and the Verbal-Imagery. The main labels included in these families are as follows.

*Wholist-Analytic Cognitive Style Family.* Field Dependence-Independence (Witkin, 1962); Impulsivity-Reflectivity (Kagan, 1965); Holist-Serialist (Pask, 1972); Leveller-Sharpener (Holzman & Klein, 1954); Simultaneous-Successive (Das, 1988); Diverging-Converging (Hudson, 1966), Wholist-Analytic (Riding & Buckle, 1990; Riding, 1991).

*Verbaliser-Imager Cognitive Style Family.* Sensory Modality Preferences (Bartlett, 1932); Verbaliser-Imager (Riding & Taylor, 1976); Verbaliser-Visualiser (Richardson, 1977).

The two basic dimensions of cognitive style may be summarised as follows:

- (1) The *Wholist-Analytic Style* of whether an individual tends to process information in wholes or parts.
- (2) The *Verbal-Imagery Style* of whether an individual is inclined to represent information during thinking verbally or in mental images.

*Assessment.* These two dimensions may be assessed using the Cognitive Styles Analysis (Riding, 1991) which is a computer-presented assessment. It attempts to assess positively both ends of the Wholist-Analytic and Verbal-Imagery dimensions. The background, development and rationale of the method are described in Riding and Cheema (1991).

These two styles are independent of one another, in that the position of an individual on one dimension of cognitive style does not affect their position on the other (the correlations between Wholist-Analytic and Verbal-Imagery measures are consistently

very low and nonsignificant; see, for example, Riding & Mathias, 1991; Borg & Riding, 1993). The dimensions are also continua.

## Cognitive Styles and Performance

### *Wholist-Analytic Style*

The Wholist-Analytic dimension derives from the work of Witkin and others on field dependence/independence and describes how an individual habitually organises information (Witkin *et al.* 1977). Analytics, as defined by Riding and Buckle (1990), are equivalent to field-independents and Wholists to field-dependents. Wholists tend to organise information into loosely clustered wholes. Analytics, by contrast, tend to organise information into clear-cut conceptual groupings. Position on the Wholist-Analytic dimension has been found to affect reading performance (Riding & Mathias, 1991), learning from structured material (Riding & Sadler-Smith, 1992), occupational stress (Borg & Riding, 1993) and occupational suitability (Riding & Wheeler, *in press*).

Wholist-Analytic Style affects the way in which people think about, view and are able to respond to information and situations. Wholists tend to see information as a whole, and are able to have an overall perspective and to appreciate its total context. By contrast, Analytics will see information as a collection of parts and will often focus on one or two of these at a time to the exclusion of the others.

For Wholists not only are the parts not separated, but there is possibly the danger that the distinction between them is blurred so that it is very difficult to distinguish the issues that make up the whole of a piece of information. By contrast, the Analytic will tend to focus on just one aspect of the whole at a time and this may have the effect of distorting or exaggerating it, or making it more prominent, with respect to the rest, and so there is the possibility of getting it out of proportion to the total situation.

The positive strength of the Wholists is that when considering information or a situation they see the whole 'picture'. Consequently they can have a balanced view and can see situations in their overall context. This will make it less likely that they will have extreme views or attitudes. The negative attribute of the style is that they find difficulty in separating out a situation into its parts.

For the Analytics, their positive ability is that they can analyse information into the parts and this allows them to come quickly to the heart of a problem. They are good at seeing similarities and detecting differences. However, their negative attribute is that they may not be able to get a balanced view of the whole and they may focus on one aspect of a situation to the exclusion of the others and enlarge it out of its proper proportion.

### *Verbal-Imagery Style*

With respect to the mode of presentation, Imagers learn best from pictorial presentation, while Verbalisers are superior from text (Riding & Ashmore, 1980; Riding *et al.*, 1989; Riding & Buckle, 1990; Riding & Douglas, 1993). In terms of the type of content, Imagers find concrete and readily visualised information easier than semantically and acoustically complex details, with the reverse applying to Verbalisers (Riding & Calvey, 1981). In learning to read, Verbalisers are superior to Imagers (Riding & Anstey, 1982).

In terms of thinking, Verbal-Imagery style affects the characteristic mode in which

people represent information during thinking, verbally or in images. If a person reads a novel they can represent the actions, happenings and scenes in terms of word associations or by constructing a mental picture of what they read. Just as we can set down our thoughts on paper in two possible ways, in words or in sketches, so we can also represent them in our minds in those two modes. We can think in words, or we can think in terms of mental pictures or images.

The style thus affects the processing of information and the mode of presentation individuals prefer and the types of task they will find easy or difficult.

The Verbal-Imagery mode of representation is a continuum with individuals placed along it. On this dimension people may be categorised as being of three types: verbalisers, bimodals or imagers. *Verbalisers* consider the information they read, see, or listen to, in words or verbal associations. *Bimodals*, in the middle, tend to use either mode of representation. When *Imagers* read, listen to, or consider information, they experience fluent, spontaneous and frequent mental pictures either of representations of the information itself or of associations with it.

All groups can use either mode of representation if they make the conscious choice, i.e. Verbalisers can form images if they try, but it is not their normal, habitual mode.

The imagery mode can also be used as a strategy by *Imagers* who are also *Analytics* in order to provide a way of obtaining a wholist view, as an image can be encompassing and a whole. Similarly, the verbal mode can be used by *Verbalisers* who are also *Wholists* to give a means of providing an analytic view.

### *The Styles Combined*

In interaction with one another, cognitive styles have been shown to affect a wide range of behaviours, including learning performance (e.g. Riding & Sadler-Smith, 1992, Riding & Douglas, 1993), training preferences (Riding & Douglas, 1992), performance in public examinations (Riding & Caine, 1993) and occupational stress (Borg & Riding, 1993).

The aim of this paper was to examine the relationship between cognitive style measures and intelligence, and to look at the effect of both on school performance.

## **Method**

### *Sample*

The sample comprised 119 12–13-year-old pupils (63 males and 56 females) from an urban middle school. The pupils in school Year 8 were in six mixed-ability groups. Four of these groups were selected for inclusion in the study by the school on the basis of timetabling convenience.

### *Materials*

The following materials were used:

(1) *Intelligence*. The British Abilities Scales Short-Form (Elliot, 1983) comprising the subtests, Speed of Information Processing, Matrices, Similarities and Recall of Digits was used. Normally, each of the subtests is administered on an individual basis, but for the present study they were given on a group basis for reasons of time given the number

of subjects. These subtests were administered to class groups of approximately 30. As a consequence of this, the administration of each subtest was slightly modified where necessary. For the Speed of Information Processing and the Matrices, the published booklets were used, as was the pro forma for Similarities, but in the case of the Recall of Digits, a pro forma was produced which listed numerically each task within this scale. The subtests were as follows:

- (a) *Speed of Information Processing.* When this scale is administered individually, the time required by each subject to complete each task has to be determined. In the present case, the subjects were allowed the maximum permitted time for each task and then told to stop, and then to go on to the next task.
- (b) *Matrices (Test F).* The subjects in their class groups worked through the task presented in a similar way to that for individual administration.
- (c) *Similarities.* The procedural difference was that the subjects wrote their responses to the tasks on the scale instead of giving them verbally to the administrator.
- (d) *Recall of Digits (Test B).* For this scale the digit sequences were read out one at a time by the administrator and the subjects wrote them down on the provided pro forma.

From the raw scores on each of the above scales, an IQ score was computed for each member of the sample using the standard British Abilities Scales procedure.

(2) *Cognitive Styles.* The Cognitive Styles Analysis (Riding, 1991), which is computer-presented and indicates an individual's position on both the Wholist-Analytic and Verbal-Imagery style dimensions by means of a ratio for each, was used.

(3) *Embedded Shapes.* A Test of Embedded Shapes (TES) (see Pearson, 1991) was constructed which comprised a Worked Example Section, a Practice and a Response Section, containing four, four and 32 items, respectively. The test required that a simple shape be located within a complex shape. The items were presented in a booklet with four per page. The simple shape was located by the side of the complex shape, but with a different orientation to its position within the complex shape. The subjects were required to indicate the embedded simple shape by drawing around it with a pencil. The simple and complex shapes were derived from overlapping arrangements of three or four circles, sometimes with the addition of straight lines. For the Response Section, the subjects were allowed 12 minutes and their score was the number of embedded shapes correctly located.

(4) *School Subject Performance.* The performance of the pupils in the sample on each of six main school subjects (mathematics, English, history, science, geography and French) was provided by the subject teachers of the school in terms of a grade of attainment on a four point scale, with four 'best' and one 'worst'.

#### *Procedure*

Pupils were individually given the computer-presented Cognitive Styles Analysis and were then given the other assessments in their class groups.

TABLE I. Correlations between the style dimensions, intelligence subtests and sex

|                                 | Wholist-Analytic | Verbaliser-Imagery | IQ     | Recall of Digits | Similarities | Matrices | Speed of Information Processing | Sex   |
|---------------------------------|------------------|--------------------|--------|------------------|--------------|----------|---------------------------------|-------|
| Wholist-Analytic                | —                | -0.04              | 0.05   | -0.01            | -0.03        | -0.10    | 0.07                            | -0.02 |
| Verbal-Imagery                  | -0.04            | —                  | 0.12   | 0.12             | 0.01         | 0.04     | 0.02                            | -0.05 |
| IQ                              | 0.05             | 0.12               | —      | 0.58**           | 0.62**       | 0.50**   | 0.55**                          | 0.10  |
| Recall of Digits                | -0.01            | 0.12               | 0.58** | —                | 0.21         | 0.12     | 0.11                            | 0.12  |
| Similarities                    | -0.03            | 0.01               | 0.62** | 0.21             | —            | 0.29*    | 0.20                            | 0.07  |
| Matrices                        | -0.10            | 0.04               | 0.50** | 0.12             | 0.29*        | —        | 0.21                            | 0.04  |
| Speed of Information Processing | 0.07             | 0.02               | 0.55** | 0.11             | 0.20         | 0.21     | —                               | -0.06 |

*p* < 0.01; \*\**p* < 0.001.

TABLE II. Correlation between style, intelligence and the Test for Embedded Shapes

|                  | IQ     | Wholist-Analytic | Verbal Imagery | Sex   |
|------------------|--------|------------------|----------------|-------|
| Embedded Shapes  | 0.47** | 0.04             | -0.04          | 0.02  |
| IQ               | -      | 0.05             | 0.12           | 0.10  |
| Wholist-Analytic | 0.05   | -                | -0.04          | -0.02 |
| Verbal-Imagery   | 0.12   | -0.04            | -              | -0.04 |

\*\* $p < 0.001$ .

## Results

The results will be considered in three sections. Firstly, the relationship between cognitive style and intelligence will be examined, then the link between those two and Embedded Shapes will be examined and, finally, the relationship between intelligence and style to school subject performance will be analysed.

### Cognitive Style and Intelligence

The correlations between the style dimensions, the intelligence subtests and sex are given in Table I.

The correlation between the two style dimensions, and with sex, were very low in accord with studies cited.

There were no significant relationships between cognitive styles and intelligence, either in terms of overall IQ, or on individual subtests. All the coefficients were very low, suggesting that style is independent of intelligence. In order to confirm that there were no nonlinear relationships which would not have been detected by correlation, scatter plots were obtained for all of the variables and in no case was there any indication of a nonlinear relationship between style and intelligence.

### Cognitive Style, Intelligence and a Test of Embedded Shapes

The correlation between style, intelligence and the Test of Embedded Shapes is shown in Table II.

The Test of Embedded Shapes (TES) did not correlate significantly with Wholist-Analytic style, but it did correlate with IQ. This was an interesting finding, as the TES was of a type similar to the Group Embedded Figure Test (GEFT) (Oltman *et al.*, 1971) which has been used to assess field-dependence-independence. Both tests are scored in terms of the number of simple shapes that can be found in a series of more complex geometrical figures in a given time. It has been questioned whether this approach to assessing style is valid as it is usually found that Field-independents are superior in performance to Field-dependents and do better on tests of intelligence (see, for instance, Goldstein & Blackman, 1978, p. 185-186; Flexer & Roberge, 1980).

This is not to question the validity of the construct of Field-dependence-independence as such, but only the method commonly used for its assessment. The GEFT has tended to be used as a more convenient alternative to the original instrument, the Rod and Fame Test. However, the correlation between them is not very high and according to Goldstein and Blackman (1978, p. 183-184) ranges from 0.30-0.65.

By contrast, the CSA positively assesses both the Wholist and the Analytic ends of

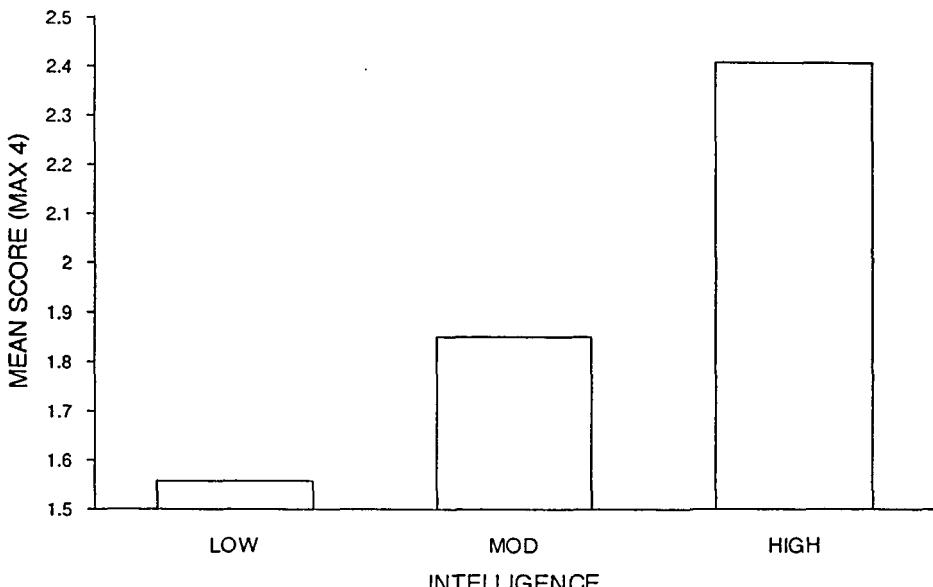


FIG. 1. Intelligence and school performance.

the dimension, and consequently probably more accurately assesses style. Certainly, previous studies have shown that the Wholists are often superior to the Analytics in performance. This will be considered in the present paper in terms of school subject performance.

#### *Cognitive Style, Intelligence and School Performance*

The obtaining of near zero correlations between tests is only of use if the tests can be shown, themselves, to actually measure performance. In order to satisfy this condition, the style and intelligence measures will be considered in terms of school performance on the six main school subjects studied by all pupils.

The sample was grouped into equal divisions on the basis of their ratios on each cognitive style dimension. The divisions were: Wholist-Analytic dimension: Wholists, 0.61 to 0.98, Intermediates 0.99 to 1.19, Analytics 1.20 to 2.39; Verbal-Imagery dimension: Verbalisers 0.80 to 1.00, Bimodals 1.01 to 1.14, Imagers 1.15 to 1.73; and also in terms of intelligence IQ: low 69 to 104, moderate 105 to 115, high 116 to 133 (the overall mean for intelligence was 109.62, SD 12.05). A series of four-way analyses of variance were done with repeated measures on school subject, to include all the combinations of IQ, Wholist-Analytic style, Verbal-Imagery style and Sex. In view of the limited size of the sample, effects will only be reported for which the minimum cell size is at least 18. This condition was not met in the case when the style dimensions were included together or with Intelligence.

(1) *Intelligence and Performance.* As expected there was a significant effect of intelligence on overall performance on the subjects ( $F = 21.47$ ;  $df 2,101$ ;  $p < 0.001$ ). This is shown in Fig. 1.

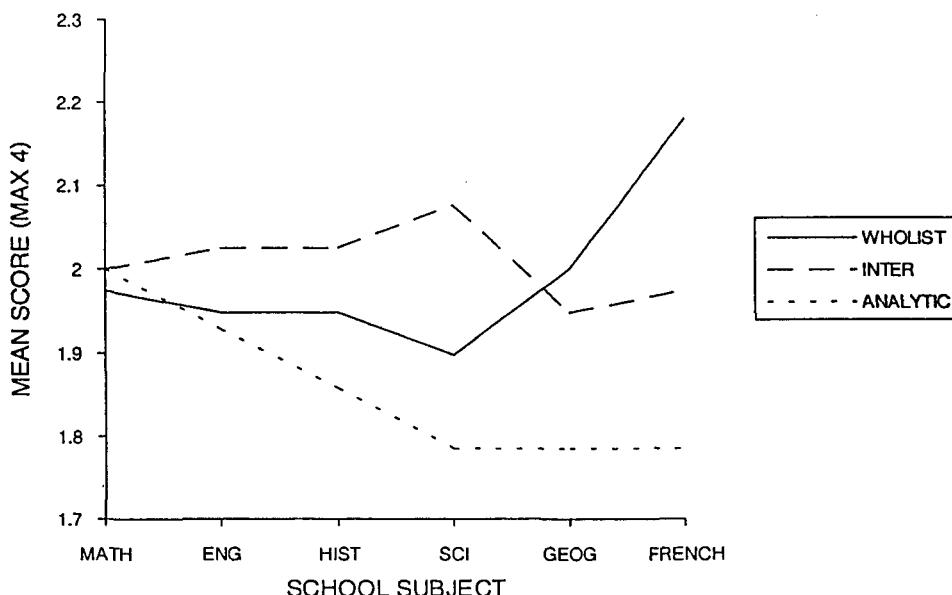


FIG. 2. Wholist-Analytic style and subject performance.

(2) *Cognitive Style and Performance.* It would be expected that performance in a subject would be influenced by the extent to which success in the subject required an overall view, or an ability to separate out the parts, or both. For some subjects, a concentration on the parts would lead to fragmentation and might be the case with French, for instance. There was a significant interaction between Wholist-Analytic style and subject in their effect on performance ( $F = 2.16$ ;  $df 10,505$ ;  $p = 0.019$ ). Wholists were superior on geography and French, Intermediates on English, history and science, with Analytics doing poorly on science, geography and French. The interaction is shown in Fig. 2.

Previous work has also indicated that the Verbal-Imagery dimension is related to extraversion-introversion (Riding & Dyer, 1980) and also that the pattern for males is the mirror image of that for females with performance against that dimension (Riding & Armstrong, 1982; Riding & Borg, 1987). There was a significant interaction between Verbal-Imagery dimension and overall performance ( $F = 0.039$ ;  $df 2,102$ ;  $p = 0.039$ ). This is shown in Fig. 3.

As in previous studies, the males in the intermediate position of Bimodal are superior, while the opposite applies to the females. The reason for the pattern is not clear and requires further investigation.

(3) *Sex and Subject Performance.* There was also a significant interaction between Sex and performance on the subjects ( $F = 3.20$ ;  $df 5,505$ ;  $p = 0.007$ ). Generally, girls were superior to males, except on mathematics and science. This is shown in Fig. 4.

The interpretation of sex differences is difficult, as it is hard to separate cultural from biological influences.

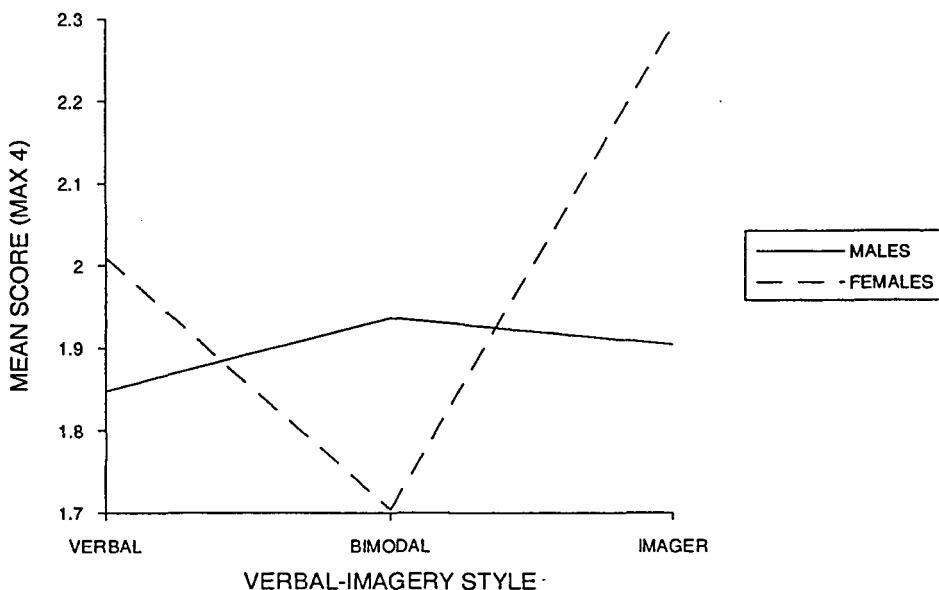


FIG. 3. Verbal-Imagery style, sex and subject performance.

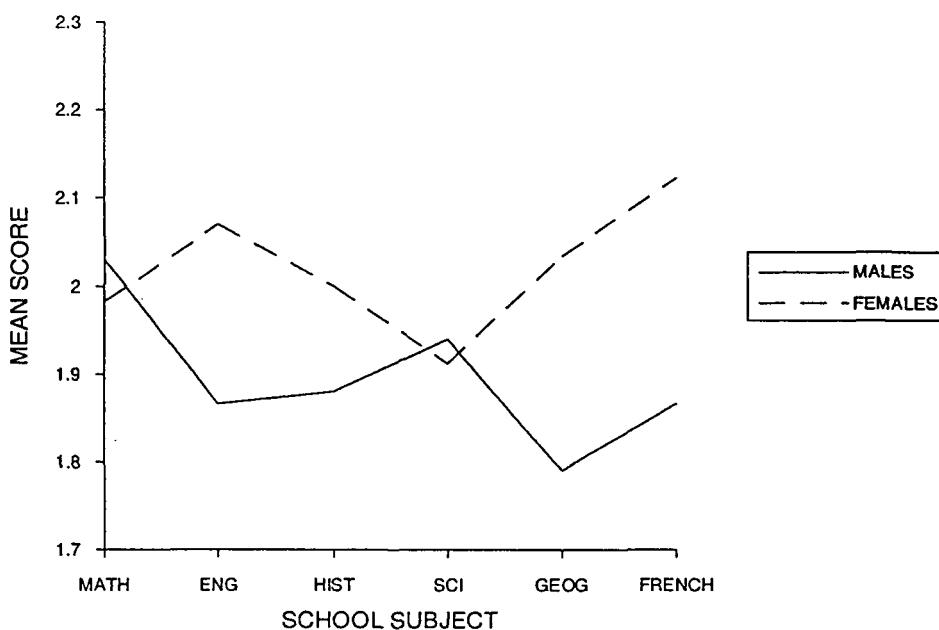


FIG. 4. Sex and subject performance.

## Discussion

### *The Distinction between Style and Intelligence*

As has been noted above, there are some who see intelligence as all embracing so that every ability is an aspect of intelligence. In the context of the present paper this view is

too broad to be useful and so a definable distinction between intelligence and style will be sought.

Both style and intelligence will affect performance on a given task. The basic distinction between them is that performance on all tasks will improve as intelligence increases, whereas the effect of style on performance for an individual will either be positive or negative depending on the nature of the task. It follows from this that for an individual at one end of the style dimension, a task of a type they find difficult will be found easier by someone at the other end of the dimension and vice versa. For instance, if the dimension were the Verbal-Imagery style, then Verbalisers would find pictorial tasks more difficult than Imagers would, but would find highly verbal tasks easier than Imagers would. In other words, in terms of style a person is both good *and* poor at tasks depending on the nature of the task, while for intelligence, they are *either* good *or* poor.

Carroll (1993, p. 56) has suggested that cognitive style is simply a manifestation of a profile of ability. The present author would wish to amplify this by pointing out two things. Firstly, a style emerges from a difference between two complimentary abilities. In order to illustrate this, one can deliberately oversimplify how the brain works and consider that within it there is one processor for verbal information and another for pictorial. If, in an individual, these two processors have unequal speed and processing capacity, then the individual will tend to use the one in preference to the other whenever possible and this will lead to the establishment of a style, or habitual preference for one over the other. Secondly, for a style to exist as a dimension, the two processors must represent opposites in some sense. In the case of the Verbal-Imagery dimension, while words are not the opposite of pictures, but merely different ways of representing information, this may have the physical basis of a shift of dominance from one hemisphere to another, (Riding *et al.*, 1993). For the Wholist-Analytic style dimension, it is possible to see a progression from the whole to the parts. The whole is in this sense the opposite of the parts; the wood comprises the individual trees.

There is also the question of the extent to which abilities are fixed over time. At a simple level of information processing, the performance of a computer on a task will depend upon both its physical structure and the programs entered into it. This distinction may be applied to human ability. A differentiation may be made between the physical architecture of the brain in terms of capacity and interconnections and structures, and the programmed characteristics (the information and skills learned). The former corresponds to fluid intelligence and the latter to crystallised intelligence (Cattell, 1967), although it is not clear to what extent the development of the architecture is influenced by the programming! The British Abilities Scale subtests assessed Speed of Information Processing (crystallised?), Matrices (fluid), Similarities (crystallised) and Recall of Digits (fluid). In terms of style, it is useful to distinguish between styles and strategies. Styles are probably architectural features. By contrast, strategies are ways that may be learned and developed to cope with situations and tasks, and particularly methods of utilising styles to make the best of situations for which they are not ideally suited.

In conclusion, intelligence as measured by the subtests of the British Abilities Scale is not related to cognitive styles. Further work is necessary to compare styles with a wider range of abilities.

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